# Resilient Infrastucture: Building For The Future

## A draft background paper for the G20 Working Group on Climate Sustainability

ADB

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ASIAN DEVELOPMENT BANK

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# ACKNOWLEDGEMENT

Upon the request of the Government of Japan, this draft report is prepared to provide inputs to the discussions at the G20 Working Group on Climate Sustainability meeting in February 2019. It is prepared by the Climate Change and Disaster Risk Management Division, with contributions from the Finance Sector Group, of the Sustainable Development and Climate Change Department, Asian Development Bank.

# ABBREVIATIONS

| | |
|---|---|
| ACIFF | Asia Pacific Climate Finance Fund |
| APAN | Asia Pacific Adaptation Knowledge Network |
| BMZ | German Federal Ministry for Economic Cooperation and Development |
| CBD | Community-based development |
| CCA | Climate change adaptation |
| CIFs | Climate investment funds |
| CRA | Climate risk and adaptation assessment |
| CRM | Climate risk management |
| DMCs | Developing member countries |
| DRR | Disaster risk reduction |
| GCF | Green Climate Fund |
| GEF | Global Environment Facility |
| GIZ | Deutsche Gesellschaft für Internationale Zusammenarbeit |
| ICT | Information and communications technology |
| IDFC | International Development Finance Club |
| IFI | International Financial Institution |
| IPCC | Intergovernmental Panel on Climate Change |
| MDBs | Multilateral development banks |
| NDC | Nationally determined contribution |
| NDF | Nordic development fund |
| PPCR | Pilot program for climate resilience |
| PPP | Public-private partnerships |
| TCFD | Task Force on Climate-related Financial Disclosure |
| UNFCCC | United Nations Framework Convention on Climate Change |

# EXECUTIVE SUMMARY

Asia and the Pacific have achieved major economic growth and poverty reduction over recent decades. Infrastructure has played a key role in this success and the Asian Development Bank (ADB) has been pivotal in its financing. Over the next decade, further investment in infrastructure is needed to maintain growth momentum and eradicate remaining poverty, estimated at $1.5 trillion/year. ADB will play a major role in catalyzing this investment, as set out in the new 'Strategy 2030'.

However, the region frequently experiences extreme weather events and geophysical shocks and it is one of the most vulnerable globally to future climate change. There is therefore a need to ensure investment in infrastructure is made to be more resilient, but also a need to enhance regional investment in disaster risk reduction and climate change adaptation. Against this background, there is an urgent impetus for prioritizing, designing, executing and scaling up investment in resilient infrastructure. This paper sets out recent ADB experience and insights in this area, and how these lessons are being used to take the resilient infrastructure agenda forward.

**Building on experience.** ADB has been a regional leader on understanding and addressing the potential impacts of disaster and climate change. This experience provides valuable insights, which in turn has led to new approaches for building resilient infrastructure.

Over recent years, ADB has changed the types of disaster risk reduction investments it finances, extending from structural projects to include nature-(or eco-)based solutions, community-based resilience infrastructure, and projects that combine structural (e.g. hard protection) and non-structural (e.g. early warning) interventions together. The organization has operationalized a climate risk management framework in the investment project cycle, and has been integrating climate adaptation in projects over the past five years, steadily increasing its financing. ADB has evolved the methods it uses for managing climate risks to investments, and is exploring approaches to investments that encourage flexibility, robustness and adaptive management.

ADB's practical experience to date has indicated that there are often informational, institutional and policy barriers to implementing resilience measures. ADB has therefore been investing in information, knowledge sharing, capacity building and partnerships. Alongside this, ADB is developing and applying approaches to address policy constraints. Further, ADB has sought to support countries with new financing approaches such as disaster contingency finance.

**Developing a future vision.** ADB's new 'Strategy 2030' aims to achieve a prosperous, inclusive, resilient and sustainable Asia and Pacific. The Strategy identifies climate and disaster resilience as an operational priority and to help deliver this at scale, ADB has set a target to provide cumulative climate finance of $80 billion by 2030 from its own resources.

However, delivering this vision will require innovative operational approaches, and additional investment types and resources. ADB is therefore moving towards a holistic resilience approach, which aims at building resilience to a wide range of shocks and stresses, and extending beyond physical infrastructure to include financial resilience, eco-based resilience, and social and institutional resilience. The benefits of such an approach are clear, it will deliver major economic benefits, but it will also build resilience at all levels, for individuals, households, communities, businesses, and nations.

Finally, to meet the anticipated investment needs for future infrastructure, as well as the changing profile of disaster and climate risks, Asia and the Pacific will need to unlock additional sources of funding, notably private investment. ADB, together with its partners, is therefore developing innovative approaches for resilience financing and leveraging.

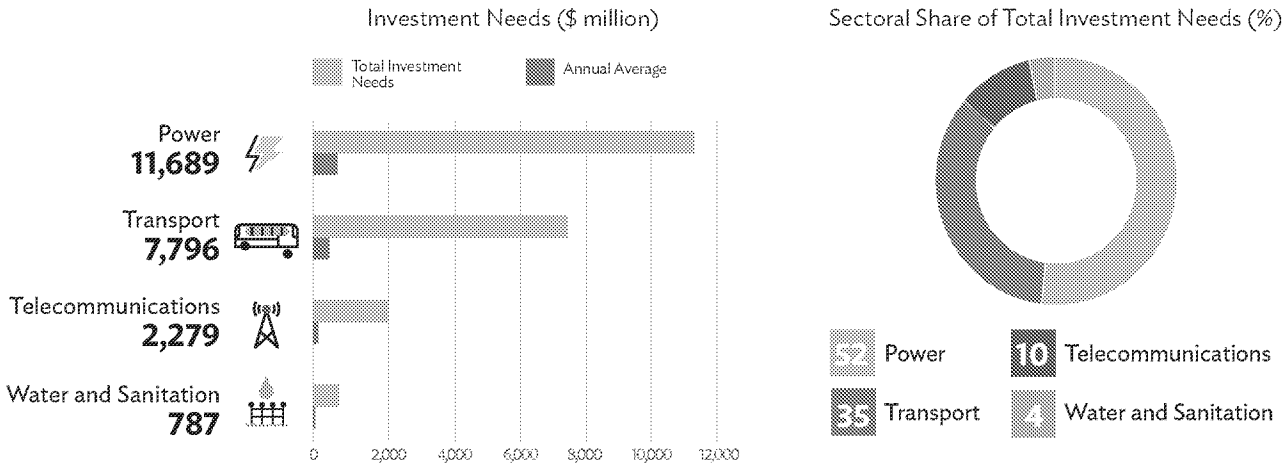
It is hoped that the insights shared in the paper are of relevance and interest to partners in the international development and finance communities, and provide inputs towards a future collaborative vision for building resilient infrastructure.

# A. INTRODUCTION

## 1. Significant investment in infrastructure is needed in Asia and the Pacific to sustain growth momentum, eradicate remaining poverty and respond to climate change and disaster risk

Asia and the Pacific have achieved dramatic progress in poverty reduction and economic growth over the past 50 years. Investment in infrastructure has played a key role in advancing this social and economic development, and the Asian Development Bank (ADB) has been pivotal in financing the region's development infrastructure. Looking forward, significant increases in infrastructure investment will be needed to maintain regional economic growth momentum and to eradicate remaining poverty: a recent study (ADB, 2017a) estimates that Asia and the Pacific will need to invest an additional $22.6 trillion in infrastructure, or $1.5 trillion per year, from 2016–2030, as shown in Figure 1. This does not include the additional investment in resilience needed to address future climate change.

**Figure 1: Estimated Infrastructure Investment Needs by Sector, in ADB's 45 Developing Member Countries, 2016–2030 ($ billion in 2015 prices)**




*Source: adopted from Table 2, ADB, 2017a.*

Over the same period, the region has experienced a significant increase in the impacts of extreme weather events such as tropical cyclones, floods, droughts, and heat waves. It has also endured major geophysical shocks, including earthquakes and tsunamis. While all countries experience natural hazards, Asia and the Pacific are particularly affected: of the 10 countries worldwide facing the highest estimated disaster risk, seven are ADB developing member countries (DMCs)[1]. These events result in significant loss of lives and high economic costs: between 2008 and 2017 alone, disasters caused over 300,000 fatalities in ADB's DMCs, affected 1.56 billion people, and resulted in reported direct physical damage totaling $496 billion, equivalent to $136 million per day.[2] The impacts of such events are also rising and global losses from weather related disasters and geophysical hazards in recent years are among the highest on record (Munich Re, 2018; Swiss Re, 2017).

Looking ahead, ongoing climate change could alter the frequency, intensity, extent, duration, and timing of extreme weather events, and is likely to result in unprecedented extremes (IPCC, 2012; ADB, 2017b). There is already evidence that human-induced global warming has increased the frequency and intensity of heavy precipitation events globally, as well as increasing risks of other extremes in some regions (IPCC, 2018; Hoegh-Guldberg et al, 2018). Climate change could also alter trends and induce shifts in the long-term average climate that will have major impacts in the region.

1 These are Bangladesh, Cambodia, the Philippines, Solomon Islands, Timor-Leste, Tonga, and Vanuatu. According to Kirch et al (2017), although it is highlighted that different risk indices place different countries in the top 10.

2 Based on date drawn from EM-DAT: The OFDA/CRED International Disaster Database, www.emdat.be, Université Catholique de Louvain, Brussels.

While the impacts of climate change could affect every region, disproportionately high impacts are projected for Asia and the Pacific. Modelling studies estimate that climate change could impose high economic costs on both South Asia and the Pacific (ADB, 2014a; ADB, 2013a), and global studies report that South and Southeast Asia will suffer economic costs double those of the global average by 2060 (OECD, 2015a). This reflects the region's exceptionally high climate vulnerability plus increasing concentration of populations in cities that are in harm's way: 9 of the 16 countries globally assessed at 'extreme risk' of climate change are ADB's DMCs[3]. In the long term, climate change presents an existential threat to at-risk countries such as small island developing states. In the context of this report, it will increase the risks from natural hazards to infrastructure, but also require additional infrastructure investment to address new shocks and stresses. Previous studies (World Bank, 2010) have estimated that East Asia and Pacific Region will shoulder the highest adaptation cost of all regions, and a high proportion of this will be for infrastructure. This calls for deliberate action to build resilience (Box 1) of the region's infrastructure to climate and disaster risks.

**BOX 1: Resilience**

There are numerous definitions of resilience. Early definitions found in the disaster risk literature focus on the ability to bounce back after shocks, particularly from natural hazards such as earthquakes and drought. In recent years, the term has been extended to include resilience to uncertain climate change, encompassing resilience to both shocks (extreme weather events) and stresses (slow-onset climate change). In this report, resilience is defined as the capacity to resist, respond or recover – maintaining essential infrastructure function - against natural hazards, including geophysical and weather-related hazards both now and over the medium and long term, with changes in weather extremes and climate trends reflecting climate change and in exposure and vulnerability to those events and trends.

## 2. ADB was an early mover on the journey towards building resilient infrastructure

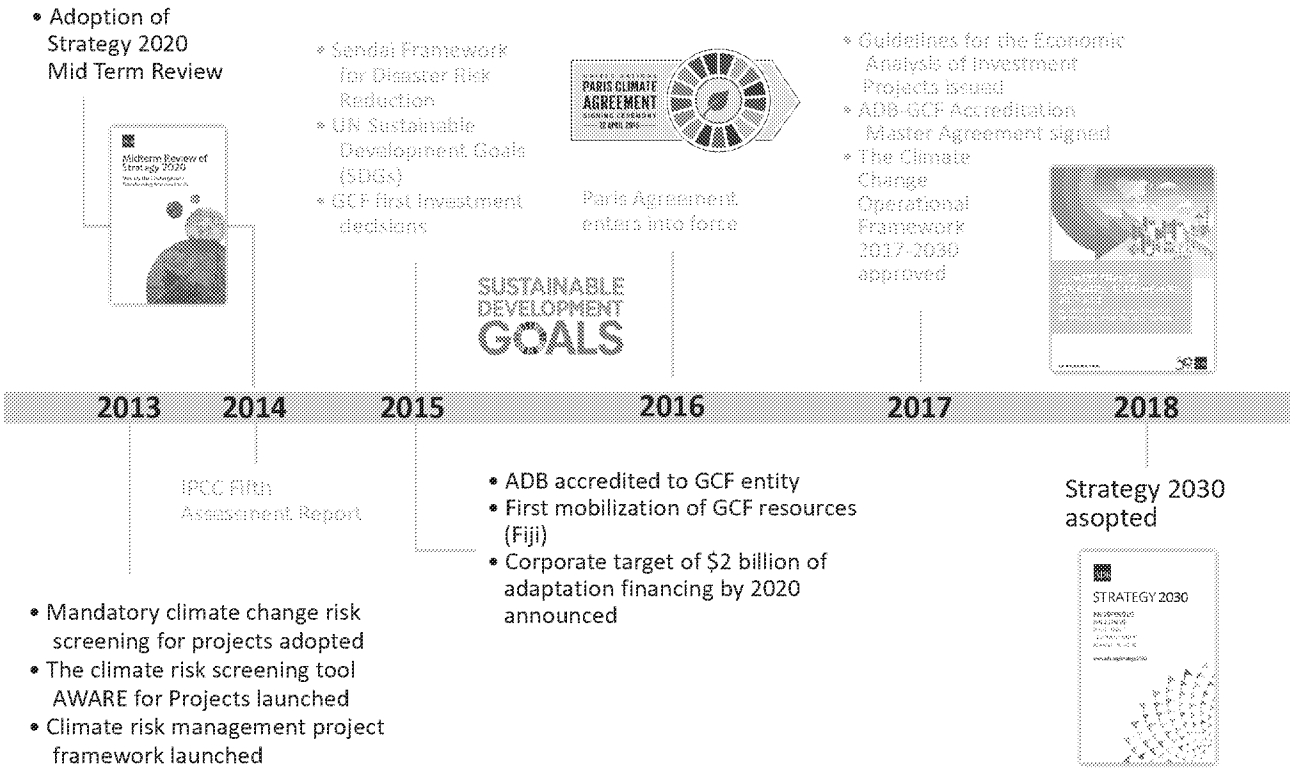
To effectively reduce the impacts of disasters on infrastructure - and to address the additional threats from climate change - requires deliberate efforts to understand, assess and manage these risks. For more than two decades, ADB has been among the leading institutions in Asia and the Pacific, as well as internationally, on understanding and addressing the potential impacts of disaster and climate change. As shown in Figure 2, ADB's recent initiatives include a well-structured climate risk management framework, which is applied to all ADB's investments. This has been supported by the development and strengthening of institutional strategies, policies and operational practices. ADB is recognized as a leader in systematically responding to climate and disaster risks in its operations, and has been widely consulted by other international financial institutions (IFIs) including multilateral development banks (MDBs)[4]. Highlighting some of the early lessons learned on building resilience of investment operations, ADB made substantive contributions to a joint MDB-IDFC publication on lessons learned in tracking adaptation finance which was launched at the twenty-fourth session of the Conference to the Parties of UNFCCC.[5] Faced with the dual challenges of meeting the formidable needs for infrastructure development, and effectively managing the growing risks of disaster loss and adverse climate change impacts, ADB is more focused and committed than ever to build on these early efforts to scale up its investments in resilient infrastructure in the coming decades.

3 The Climate Change Vulnerability Index (CCVI) (Maplecroft, https://www.maplecroft.com/about/news/ccvi.html) rates 16 countries as having 'extreme risk', many of which are in Asia: Bangladesh (ranked 1), India (2), Nepal (4), Philippines (6), Myanmar (10), Cambodia (12), Vietnam (13), Thailand (14) and Pakistan (16). Different climate risk indices alter the order of countries, but all identify high risks in Asia and the Pacific.

4 For example, the Islamic Development Bank has requested technical advice and inputs to the development of its climate change strategy and climate risk management framework; the European Investment Bank and the Inter-America Development have both followed the lead of ADB in adopting climate risk screening; extensive technical engagement took place between ADB and KfW and AFD, where the latter sought advice on the establish of a climate risk management framework and its supporting system.

5 The full publication is available at https://www.idfc.org/wp-content/uploads/2018/12/mdb_idfc_lessonslearned-full-report.pdf.

**Figure 2: Recent milestones in ADB's journey in building disaster and climate resilience**




*Source: Asian Development Bank (ADB).*

## 3. Purpose of the report

At this critical juncture for ADB, this paper sets out ADB's experience and lessons to date on resilient infrastructure, and highlights opportunities for future partnerships and synergies, as well as new financing modalities. It is expected that insights shared here would be of relevance and interest to partners in the development and finance communities regionally and internationally, in support of the delivery of resilient infrastructure in the Asia and Pacific region, and beyond.

Following this introduction, the paper will synthesize ADB's experience to date in building public infrastructure resilience to climate and disaster risks in Section B, in three key areas: (1) corporate resilience strategy, policies and approach (B.1); (2) financing operations for building climate and disaster resilience through investing in a wide range of structural and non-structural resilience interventions (B.2); and (3) knowledge and partnerships (B.3). Taking a forward looking perspective, Section C identifies priority areas of work and opportunities to scale up investment in climate and disaster-resilient infrastructure. Section D concludes the paper with a set of key messages highlighting the learning so far and opportunities to deliver climate and disaster-resilient infrastructure at scale in Asia and the Pacific.

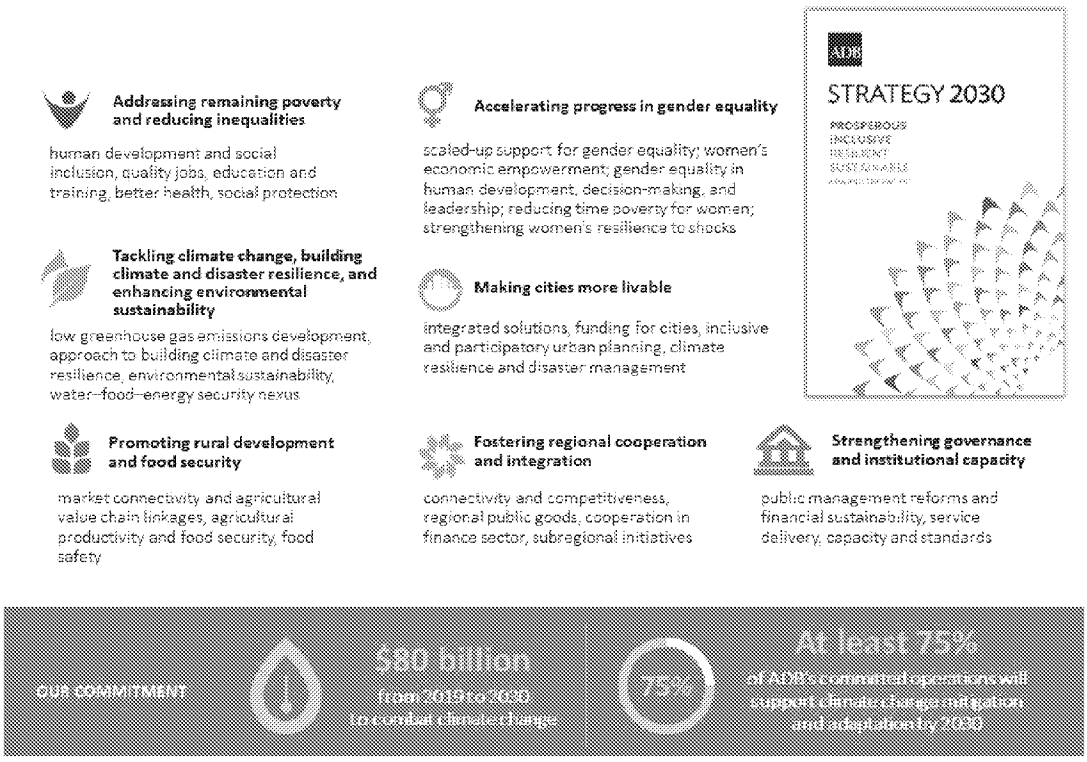
# B. ADB's experience in building climate and disaster resilience of public infrastructure

## 1. ADB's corporate strategy, policies and approach to resilience

### *1.1 Building climate and disaster resilience is an corporate strategic priority*

ADB has been on the journey of managing climate and disaster risks to infrastructure investments for the past two decades. With growing scientific and empirical evidence of material disaster and climate risks, ADB's 'Strategy 2030' has set out the vision of a prosperous, inclusive, resilient and sustainable Asia and Pacific (ADB, 2018a). The Strategy identifies seven key operational priorities, one of which is *'tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability'*. This calls for a major scaling-up of investment in climate and disaster-resilient infrastructure development. To support this, ADB has set ambitious targets: (1) that at least 75% of the number of its committed operations (on a 3-year rolling average, including sovereign and non-sovereign operations) will support climate change mitigation and adaptation by 2030; and (2) that climate finance from ADB's own resources will reach $80 billion for the period 2019–2030 (Figure 3). In addition, it also recognizes that action on climate change and disaster resilience can support the delivery of the other operational priorities in Strategy 2030[6] by moving to a more **holistic approach to resilience** (see Section B1.2 below).

**Figure 3: Operational Priorities and Climate Change Targets in ADB Strategy 2030**



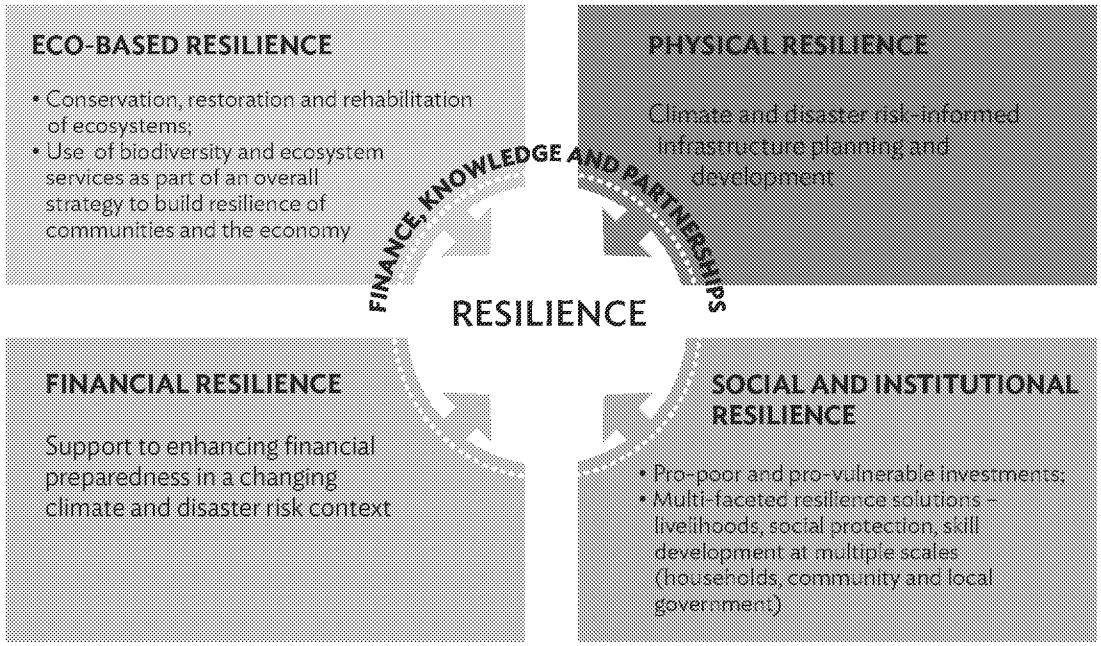

*Source: ADB.*

6 The other key operational priorities are: addressing remaining poverty and reducing inequalities; accelerating progress in gender equality; making cities more livable; promoting rural development and food security; strengthening governance and institutional capacity; and fostering regional cooperation and integration.

### *1.2 ADB is taking a holistic approach to resilience*

To deliver ADB's Strategy 2030 priority to build disaster and climate resilience in the context of delivering prosperous, inclusive and sustainable development, a shift in focus is required. In response, ADB has advanced a **holistic resilience approach**. This aims to build climate change and disaster resilience from four key perspectives: physical infrastructure resilience, financial resilience, eco-based resilience, and social and institutional resilience (Figure 4). This will deliver resilience at all levels, for individuals, households, communities, businesses and nations. This holistic approach can be seen in the broader context of sustainable development, and includes a number of priorities.

**Figure 4: A Holistic Approach to Resilience**




*Source: ADB.*

First, infrastructure projects should be planned, designed and built taking climate change and disaster risks into account, i.e., **physical resilience**. ADB has made major progress in this area, including through the development and implementation of its project climate risk management (CRM) framework (See Section B1.3 below). It also includes the scale-up of infrastructure investments in disaster risk reduction and climate change adaptation[7].

Second, there should be greater emphasis on biodiversity and ecosystem services as part of an overall strategy to help people adapt to climate change and manage disaster risks, i.e., **eco-based resilience**. ADB is supporting approaches such as coastal protection, nature-based river-basin flood risk management, erosion control, and urban water management.

Third, there should be a focus on the human and social dimensions of climate and disaster resilience, i.e., **social and institutional resilience**. This reflects the mutually reinforcing nature of poverty and vulnerability to climate change and natural hazards and the disproportionately high impacts of climate change and disasters on poor and vulnerable populations. ADB is initiating a project to help prioritize investments with an explicit focus on the poor and vulnerable to ensure that "no one is left behind".

7 It is useful to distinguish between two types of resilience infrastructure investments. The first seeks to ensure that new infrastructure investments are made more resilient, i.e. increasing the resilience of infrastructure through decisions relating to their location, design, construction and operation. The second recognizes the need to increase infrastructure investment for disaster risk reduction and climate change adaptation itself, i.e. increasing resilience through investment.

Finally, there should be strong and effective financial management of residual disaster risk on the part of countries, businesses, and communities, i.e., **financial resilience**, in turn supporting timely relief, early recovery and reconstruction efforts and incorporating measures to build back better. ADB is supporting DMCs to develop financing instruments such as disaster contingent financing, and risk transfer mechanisms, such as disaster insurance, and enhance post-disaster budget execution strategies in this regard.

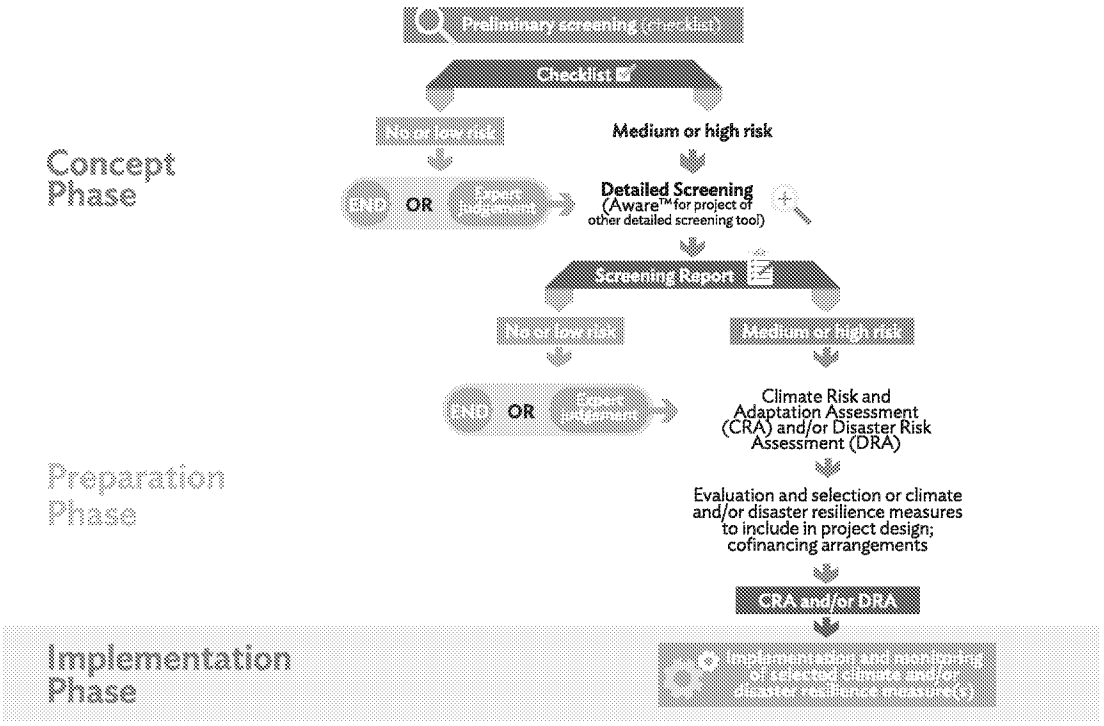
### *1.3 ADB has established a climate risk management framework*

Since 2013, ADB has been implementing its CRM framework for projects. As illustrated in Figure 5, the CRM framework consists of the following steps:

- Context-sensitive climate risk screening at the concept development stage to identify projects that may be at medium or high risk;
- Climate risk and adaptation assessment (CRA) in the preparation of projects that are assessed as at risk;
- Identification and technical and economic evaluation of adaptation options in project design; and
- Monitoring and reporting of the assessed level of climate risk

More recently, project teams have also been estimating and tracking the level of adaptation finance while disaster risk concerns, including near-term disaster risks and risk emanating from geophysical hazards have been incorporated into the CRM framework.

**Figure 5: Climate Risk Management Framework**




*Source: ADB.*

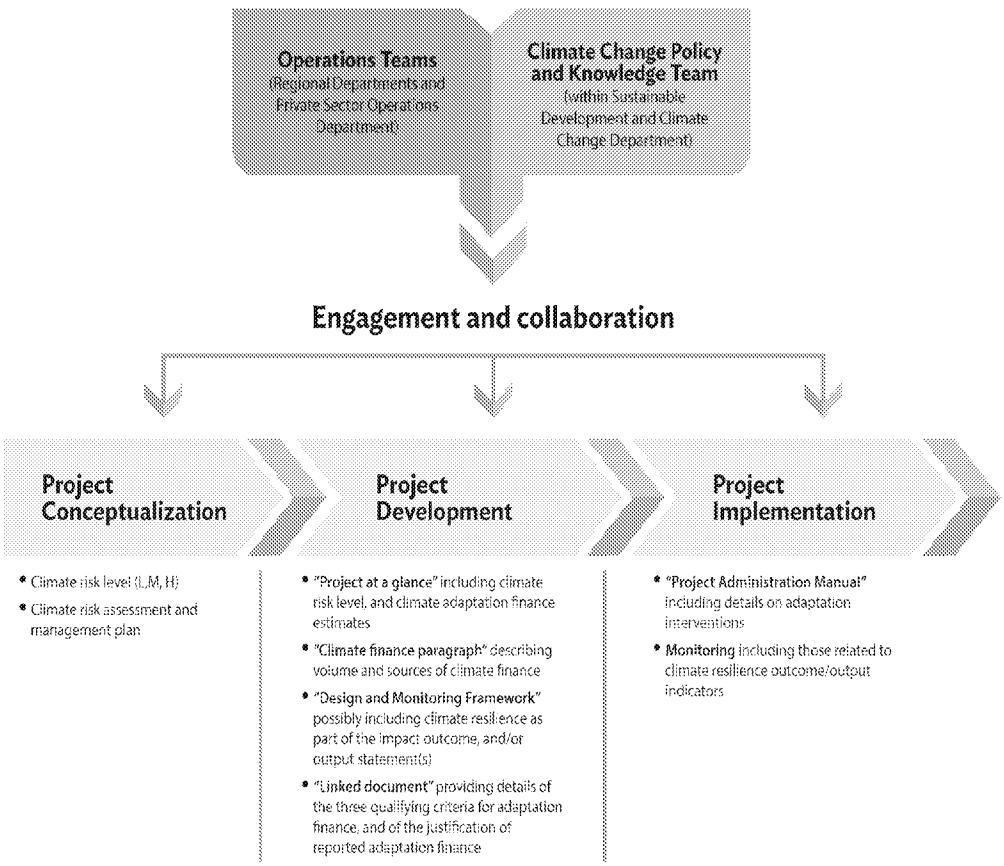
As part of the implementation of this framework, the assessed level of risk, and the estimated adaptation finance, are reported in key project documentation.[8] As illustrated in Figure 6, this involves close collaboration and coordination between operational teams and technical climate change teams. Project concept papers and key documentation are

8 A paragraph is usually included in the Due Diligence section of the project's Report and Recommendation of the President to the Board of Directors which describes the climate risks identified, along with a brief description of the proposed strategy to address these risks. A linked document on Climate Change Assessment is also required for projects at medium or high risk as determined by risk screening. If a more detailed climate risk and adaptation assessment (CRA) has been conducted, it is often included as a supplemental document.

systematically reviewed to help ensure CRM quality and standards within projects. In addition, ongoing technical support is provided, through both in-house and external experts to project teams, particularly for CRAs. Through ADB's internal Climate Change Fund (CCF),[9] financial support is also provided to project teams for carrying out CRAs and/or implementing adaptation measures. In addition, ADB has made notable strides in assisting its DMCs in securing external concessional and grant financing in resilient public infrastructure development (see Section B2 below).

To take stock of current practices in implementing the CRM framework, a comprehensive review has been carried out to assess how effective the current generation of CRAs are in helping teams to design and implement more climate-resilient projects, i.e. are they fit for purpose? Important insights have been gained through this exercise. These includes, among others: (1) compared with the frameworks developed by other MDBs, ADB's approach is judged to be relatively pragmatic and proportionate; however, (2) there are opportunities to improve procedures and to strengthen the overall quality of project design to deliver climate-resilient results; (3) economic analysis behind some publicly visible adaptation projects can be strengthened; (4) bespoke guidance is needed to adapt investments in the coastal zone and built environment given their high exposure and vulnerability to climate hazards; and (5) there may also be scope to trace the value added by CRAs to the eventual design and delivery of resilience investments through longitudinal analysis of completed projects. Efforts are already well underway to further improve the CRM framework and strengthen its implementation (see Section C1 below).

**Figure 6: Collaboration and Coordination for Climate-Resilient Project Development at ADB**



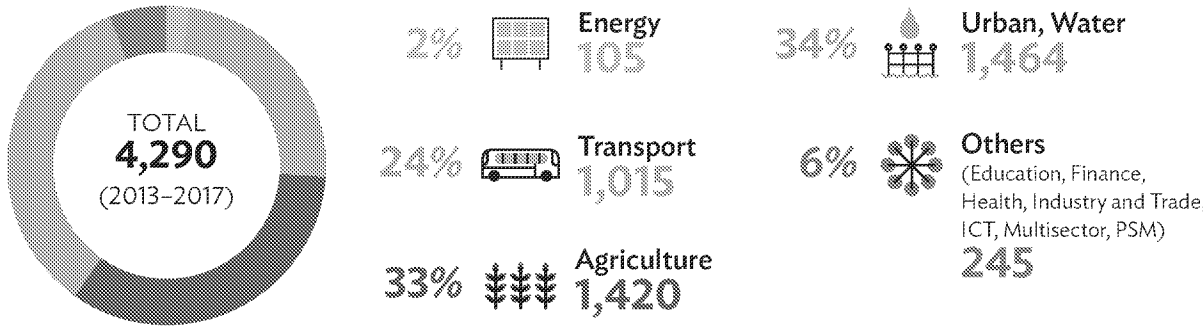

*Source: ADB.*

9 The CCF was established in 2008 to facilitate greater climate change investments in DMCs. CCF provides financing through four modalities: grant component of investments, technical assistance (stand-alone and piggy-back or linked to loan), and direct charge. It has four components: (i) adaptation, (ii) clean energy development, (iii) reduced emissions from deforestation and forest degradation, and improved land use management (REDD+ and land use); and (iv) climate finance readiness. As of June 2018, the CCF has received a total of $74 million ADB financing. $22.7 million of the $74 million total CCF resources has been allocated to 48 projects on adaptation.

## 2. Financing the development of climate and disaster resilient public infrastructure

Guided by its strategies and in response to the needs of its DMCs, ADB has been steadily increasing its finance in resilient infrastructure development, particularly in sectors that are more vulnerable to climate and disaster impacts. As shown in Figure 7, during the five-year period of 2013-2017, ADB invested a total of $4.29 billion on adaptation from its own resources, to improve the climate resilience of infrastructure investments in mostly urban and water development, agriculture, transport and energy sectors.

**Figure 7: Adaptation Finance ($ million) from ADB's Own Resources**




*Source: ADB.*

In addition to dedicating its own resources for investing in resilience, ADB has played a key role in the international climate finance architecture. It has worked with other MDBs to operate a number of the most important climate funds that are focused on resilience, notably the Pilot Program on Climate Resilience under the Climate Investment Funds (CIFs). It has also worked with the Green Climate Fund (GCF), leveraging concessional finance to support resilient infrastructure investment projects for some of the most vulnerable countries in the region. ADB has also sought co-financing from bilateral donors to increase the support for climate and disaster resilience investment in its DMCs and established a set-aside under the 12th replenishment of the Asian Development Fund (ADF 12) specifically for investment in disaster risk reduction, including incremental costs to strengthen the resilience of transport, water, energy and other infrastructure. Box 7 in Section B.3 below provides details on some of these efforts.

The remainder of this Section presents a collection of resilience practices financed by ADB. These efforts encompass investments aimed at strengthening the disaster and climate resilience of public infrastructure through a variety of approaches, taking into account the four dimensions of resilience (i.e. physical, financial, eco-based, social & institutional) as discussed in Section B1.2 above.

### *2.1 Building climate and disaster resilient-infrastructure*

As discussed above, ADB has adopted a risk management approach to infrastructure planning and implementation, with risk screening and climate and disaster resilient design. For structural solutions, this has focused on two types of infrastructure investments.

- **Increasing resilience through investment**, with infrastructure designed for disaster risk reduction and climate change adaptation. While ADB has invested in disaster risk reduction for natural events and geohazards for many years, in future years, this is being complemented with a greater focus on infrastructure for climate adaptation.
- **Increasing the resilience of infrastructure investments**, by making sure that planned infrastructure investments take account of disaster and climate risks in their location, design, construction and operation.

*Infrastructure for strengthening climate and disaster resilience*

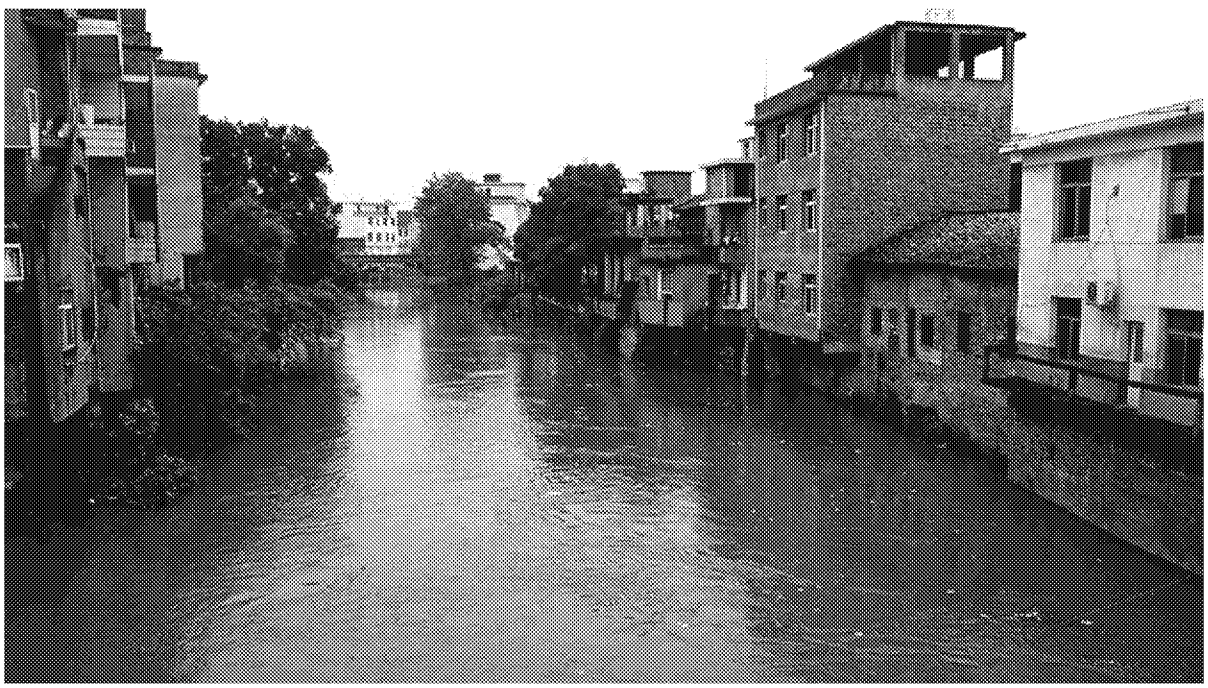
Investing in disaster risk reduction (DRR) infrastructure, such as flood risk management infrastructure, has multiple benefits. As well as avoided fatalities and injuries, it reduces damage and losses, and can create confidence for wider

economic growth by lowering risk (Lloyds, 2018). Numerous reviews highlight the high economic benefit to cost ratios of DRR infrastructure investments (Mechler, 2016; ECONADPT, 2016).

There are well-established methods for designing infrastructure for disaster risks. These build on risk assessment methods, including hazard, exposure and vulnerability analysis. ADB routinely applies these methods and uses these in the design of resilience projects across the region.

ADB has also been investing more in **nature-based solutions**, complementing hard engineered structures for disaster risk reduction and climate resilience building (Shreve and Kelman, 2014). This is also referred to as the integration of green and grey infrastructure. Nature-based solutions use eco-resilience and ecosystem-based adaptation to provide disaster risk reduction and climate change adaptation, for example with coastal storm protection provided by mangroves, or the use of wetlands in water regulation and flood management. These approaches recognize the ecosystem services that these natural habitats provide, including their regulating (resilience) functions, but also their high co-benefits, including environmental benefits and livelihood opportunities. For example, the ADB project in Pingxiang, in the People's Republic of China, is piloting natural solutions (sponge cities) to address increased flood risk, inadequate drainage infrastructure, and to improve wastewater treatment (ADB, 2015a). The project integrates the use of forests, wetlands, green roofs, bio-retention and surface water infiltration systems with more traditional grey solutions to deliver urban-rural flood risk management and ecological river management (Figure 8).

**Figure 8: An ADB project in Pingxiang, People's Republic of China, is helping protect floodplains, restore wetlands, and create wider green spaces along rivers.**



*Source: ADB.*

Further, ADB is investing in social and institutional resilience, targeting vulnerable groups with **community-based resilience infrastructure**, to ensure no-one is left behind. This involves projects that work at the local and small-scale. For example, ADB is supporting the Government of Myanmar in strengthening community resilience by designing a project that delivers resilient community infrastructure and livelihood. The selection of geographical areas for such project is being based on the analysis of multi-dimensional vulnerability, particularly natural hazards and the effects of climate change. The project will use a community-based development (CBD) approach, which encourages communities to design and implement tertiary infrastructure and associated livelihood support solutions that address their needs, along with strengthening of the institutional and organizational capacity of communities and government.

*Enhancing the resilience of infrastructure*

Natural hazards and climate change can affect infrastructure through the loss and damage to assets, increased operation and maintenance costs, reduced revenues, and lower socio-economic benefits (the wider benefits to the economy). They therefore affect the financial and economic performance of projects. These impacts can be reduced by enhancing the resilience of infrastructure.

ADB has been at the forefront of infrastructure resilience to disasters and future climate change, the latter sometimes termed climate proofing. Climate proofing seeks to ensure that infrastructure projects are designed to reduce or minimize potential impacts of climate changes, including changes in the frequency and intensity of extreme weather events. It has been advanced through the implementation of the CRM framework set out in Section B1.3. Box 2 provides three examples where climate and disaster resilience measures have been incorporated in the design of infrastructure investment projects.

**Box 2: Making infrastructure investments climate and disaster-resilient**

**Enhancing the engineering design specification**
The Central Mekong Delta Connectivity Project (ADB, 2013b). This is an $860 million investment to enhance connectivity between agricultural and agro-processing provinces of southern Viet Nam with major national and regional markets. The project includes two major bridges (Cao Lanh and Van Cong) which cross the Mekong River, and a 15-kilometer road connecting the two bridges. A study was conducted to assess the vulnerability of the project to climate change (in particular sea level rise) and examine possible climate-proofing options. The study found that the embankments of the connecting road (between the two bridges) were vulnerable to the projected increase in frequency and intensity of flooding exacerbated by sea level rise. Based on these findings, one of the resilience project design features recommended is to raise the current design height of the road embankment by an extra 0.6 meters in response to the changes in the intensity of the 1-in-100 flood event under a changing climate (ICEM, 2012).

**Building back better**
Following the 2015 earthquake in Nepal, ADB has focused on 'build back better' design. ADB has assisted the government to accelerate recovery and reconstruction following the devastating earthquake in April 2015 and major aftershocks with the Earthquake Emergency Assistance Project. Using key lessons from the ADB-funded School Sector Program (ADB, 2011a), in which school buildings withstood the 7.8 magnitude tremor of the 2015 earthquake, schools, roads and settlements are being rehabilitated and reconstructed by incorporating 'build back better' design features, which strengthen both the disaster resilience but also the future climate resilience of infrastructure developments.

**Allowing for flexibility in project design**
ADB financed a $25 million project that rehabilitated and expanded the capacity of Avatiu port in the Cook Islands. The project widened the harbor entrance, undertook dredging to increase the depth, and enlarged the ship turning area It also reconstructed and realigned the quay, repairing the adjacent wharf deck. Following the climate risk screening, the project modified the design, so as to consider future climate change. The project climate-proofed the wharf by replacing the existing structure—which was extremely vulnerable to wave action and forces—with one that including flexibility in design. This involved strengthening the pilings during construction to increase the load bearing capacity, so that the wharf can be raised more easily in the future, if this is required because of faster rising sea levels (ADB, 2008)

## *2.2 Other solutions for building climate and disaster-resilient infrastructure*

The focus above is on infrastructure, whether to enhance DRR, or to make new infrastructure investments more resilient. However, there are a number of barriers that often make it difficult to deliver resilience, due to information, governance, policy and market failures (Cimato and Watkiss, 2017). ADB has therefore been expanding its approach to address these issues and help scale up resilient infrastructure. Recent work on policy and finance are set out below, while information and capacity initiatives are discussed in Section B3 below.

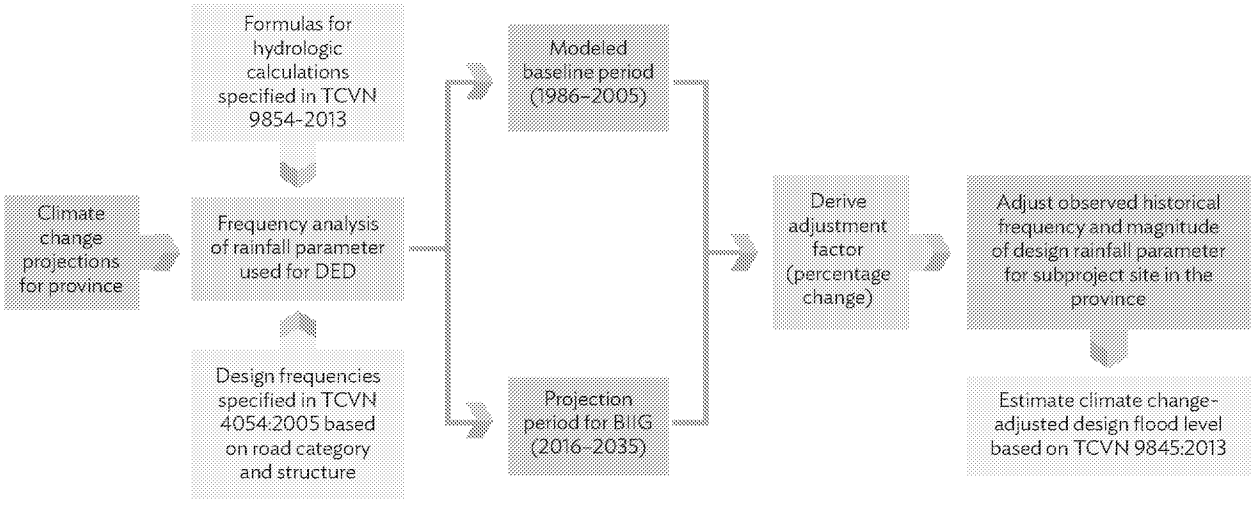
*Policy and regulatory interventions*

There can be institutional and/or policy barriers to building resilience features into infrastructure projects, especially when it comes to future climate change. One such example concerns engineering standards. Many countries have existing engineering design standards, building codes, etc. that set mandatory safety and performance criteria for new construction, but these are typically based on historic weather extremes and do not take account of the changing climate and its consequences. These standards can act as a barrier to future climate resilience, because exceeding the current engineering standards (with higher levels of resilience) is not required under existing practice. The additional costs involved cannot always be justified as the infrastructure already meets national performance criteria. This could be a barrier to implementing resilience measures identified at the project level.

This barrier can be addressed by working with countries to update their building codes and engineering design parameters to account for the changes in the characteristics of design extreme weather events (Wilby and Keenan, 2012). ADB has been making efforts in this regard. For example, during the project preparation phase for the Basic Infrastructure for Inclusive Growth in the Northeastern Provinces Sector Project in Viet Nam, work was carried out to adjust the road design parameters to account for the changes in 1-in-25 year extreme rainfall events in the future (ADB, 2017c). In line with the relevant government decree and regulations governing the road design standards (e.g. for Category 4 rural roads, 1-in-25 is defined as the design frequency, and a set of formulas are specific for hydrologic calculations), analyses were undertaken to estimate the engineering design parameters under future climate conditions (ADB, 2018b) (Figure 9). These enable the update/adjustment of the design parameters which provides the design protection as defined in the national design standard in a changing climate. The analyses essentially entailed translating climate model projections of future climate into climate 'safety margins' for standard variables such as heavy precipitation, wind speeds, wave heights, sea level rise and river flow. Case studies have also been developed to show step-by-step how this approach can be applied in practice (ADB, 2019a).

**Figure 8: Adjusting Hydrological Inputs to Road Design for Climate Change Risk Based on Extreme Value Analysis**

TCVN – Vietnam Standard; DED – detailed engineering design; BIIG – Basic Infrastructure for Inclusive Growth project




*Source: ADB.*

*Financial solutions*

ADB is helping countries strengthen their financial resilience to residual disaster risk. It is supporting DMCs to help ensure timely and adequate flows of post-disaster funding by enhancing associated financing arrangements, including through analysis of disaster risk and related relief, early recovery and reconstruction funding needs and gaps; the preparation of comprehensive disaster risk financing strategies; the development and implementation of disaster risk financing instruments; enhancement of post-disaster budget execution strategies; and the positioning of post-disaster financing instruments within a broader resilience framework.

As an example, ADB has established disaster contingent financing for five Pacific Island countries - Cook Islands, Palau, Samoa, Tonga and Tuvalu - which allows these countries to access immediate liquidity following a disaster. The financing is provided through ADB's policy-based loan instrument. Under these projects, prior policy and monitorable actions focusing on measures to enhance resilience are agreed, including actions that directly or indirectly enhance infrastructure resilience. The achievement of the prior actions (completed before loan approval) enables eligibility to disburse funds. However, funds only disburse, in part or in full, in the event of a pre-agreed trigger event in the form of the declaration of a state of disaster in accordance with national legislation. They are then be spent through the national budget. Tonga's $6 million contingent financing disbursed in full 3 days after the country was struck by Tropical Cyclone Gita in February 2018, demonstrating the rapidly disbursing capability of this instrument. ADB is currently processing a new contingent disaster financing line for Tonga as well as for four further countries in the Pacific.

There are also opportunities to support countries through enhanced insurance, which could provide an important source of leveraging to the private sector. Insurance is a risk spreading mechanism. It can build resilience through a more efficient allocation of resources to address high impact, lower frequency disasters and is therefore an important part of a layered risk management strategy. It is also a complementary tool to adaptation for future climate change[10]. As an example, ADB has been investing in insurance, with a Pilot Project on Weather Index Based Crop Insurance (WIBCI) in Bangladesh. This has shown the high demand for such products.

There are also opportunities for national risk pooling facilities, including at macro and regional level. Along these lines, ADB has designed a city government disaster insurance pool for the Philippines to provide rapid post-disaster financing for early recovery following earthquakes and typhoons. The pool arrangement reduces premiums via risk diversification, economies of scale and profit retention. Initial pool capital will be provided by the national government, which is expected to secure a sovereign loan from ADB for this purpose. The pool is expected to be launched in 2020, scaling up relatively quickly.

ADB is also encouraging the use of financial risk management products to address the risks associated with investments in climate change mitigation and adaptation and, in turn, to catalyze climate change financing from a broad range of sources, including the private sector. In this regard, it has collaborated with the German Federal Ministry for Economic Cooperation and Development (BMZ) to establish the Asia Pacific Climate Finance Fund (ACliFF), This fund is configured to identify and support the implementation of innovative financial risk management approaches, products and services that directly address: (i) climate investment risk, including barriers for adopters and financiers, such as lack of familiarity with climate technologies, quality concerns regarding installation and maintenance, and other performance-related uncertainties and (ii) extreme weather risk, improving resilience and reducing vulnerability to climate impacts, particularly of poor and vulnerable communities, including through index-based flood or drought crop insurance, disaster risk insurance for microfinance institutions, and emergency liquidity facilities. Instruments supported through the fund include guarantees and insurance.

## 3. Leveraging through Knowledge and Partnerships

As highlighted in its Strategy 2030, ADB prides itself as a financier and catalyzer of finance, as well as a knowledge provider and convener of partnerships (ADB, 2018a). In support of this vision, ADB's Climate Change Operational Framework, 2017-2030 sets out plans to improve the internal cooperation and coordination on knowledge and knowledge sharing (ADB, 2017e). This includes plans to develop a range of knowledge solutions for DMCs and strengthen partnerships and networks to deliver climate finance, foster policy dialogue and assist the implementation of Nationally Determined Contributions (NDCs) in its client countries. This section highlights some of the key knowledge activities underway aimed at enhancing the knowledge base and supporting climate-resilient investment decision making and partnerships that have been helping catalyze action and finance for climate-resilient investment.

10 Insurance spreads the financial risks of probabilistic extreme events, which might increase under climate change, but it cannot insure against climate change trends, as the risk spreading mechanism breaks down and premiums become unaffordable. Increasing risks due to climate change will be factored into premiums by insurance providers, which may make it harder to secure affordable insurance for more vulnerable individuals and places (UNEP, 2018).

### *3.1 Supporting resilient investment decision making through knowledge development and learning*

Access to information, knowledge and availability of capacity is fundamental to effective climate action. Decision makers, investors and practitioners for infrastructure development require access to actionable information and knowledge that enables the formulation of policies and programs/projects supportive of their climate and development objectives. In addition, given the complexities concerning the uncertainties associated with climate change and its impact and thus the complexities regarding the effective management of climate and disaster risks, all infrastructure development stakeholders need to be assisted in strengthening their capacity to plan, develop, design and implement climate resilient policies and programs/projects.

ADB's efforts on knowledge provision in support of climate and disaster resilient investments have focused on three main areas: data and information required for understanding climate and disaster risks; analytical methodologies, methods and tools for assessing climate risks and adaptation interventions; and original analyses and insights that contribute to the broad knowledge base and understanding.

As an example of data and information, ADB has produced guidance on Disaster Risk Assessment for Project Preparation (ADB, 2017c), as a basis for integrating disaster risk considerations in the design and implementation of individual projects. This includes technical guidance and data sources for the analytical steps of disaster risk assessment, as well as information on disaster risk reduction interventions.

Similarly, it is recognized that climate change involves complex technical information that can act as a barrier to climate-resilient design. ADB has therefore been investing in climate change information to help address this, recognizing that such information is a public good. An example is the Regional Climate Projections Consortium and Data Facility in Asia and the Pacific.

This responds to requests from ADB DMCs, on the need for stronger integration of climate change into their development process and subsequently into climate change adaptation programs, projects, and their respective country operations business plans[11]. This technical assistance project was developed to support these countries by (i) providing scientifically sound and decision-oriented climate data and projections; and (ii) enhancing their technical capacity to generate, interpret, and apply climate information. This is leading to a regional climate projections and data facility. This in turn will lead to improved climate-resilient programs and project design in selected DMCs.

ADB has also had a strong focus on knowledge products. In terms of target audience, these products are designed to serve either a general readership (i.e. as public goods) and program/project development practitioners (i.e. operational support). ADB has been actively engaged in the provision of a wide range of knowledge products, through, among others, commissioning targeted research, documenting project experience on the ground as part of the ongoing monitoring and learning efforts, implementing knowledge and support technical assistance projects. Box 3 provides an indicative list of key knowledge products that ADB and its knowledge partners have developed in the area of climate and disaster risk management.

Merely making data, information and knowledge available will not, however, lead to the uptake or application of such knowledge products. Indeed, ADB attaches equal importance to the dissemination of knowledge products and capacity building through knowledge events and dedicated training sessions. For example, as an ADB-wide collaborative effort, two workshops/clinics on nature-based approach to resilience were held in 2015 and 2017, respectively. At these workshops, insights and practical experiences on international good practices, challenges and opportunities for scaling up the application of nature-based solutions for building resilience were shared among internationally renowned experts and practitioners in the subject, and representatives from ADB staff and DMC governments. This has contributed to a growing portfolio of ADB investment projects embedding nature-based solutions in project design. As part of the efforts to further strengthen ADB's project CRM framework, a staff training workshop was held

11 The country partnership strategy (CPS) is ADB's primary platform for designing operations to deliver development results at the country level. ADB works with each DMC to map out a medium-term development strategy and a 3-year country operations business plan (COBP) to implement it.

to familiarize operations teams with a more "fit-for-purpose" CRM framework (see Box 4). Another key knowledge event to highlight is the 6th Asia Pacific Adaptation Knowledge Network (APAN) Forum, held in 2018 (see details in Box 5).

## Box 3: An indicative list of ADB knowledge products in support of climate and disaster resilient investments

### General knowledge products (public goods)

*Data, information and compendium of technical resources*

- (2017) The Regional Climate Consortium for Asia and the Pacific (RCCAP) Web Portal which provides access to climate data, technical resources and case studies (http://www.rccap.org)
- (2017) Climate Change Finance at ADB database which provides project level details on investment in adaptation (as well as mitigation), at project level (https://data.adb.org/dataset/climate-change-financing-adb)
- (Forthcoming in 2019) Climate Risk Country Profile series
- (2018) Information Sources to Support ADB Climate Risk Assessments and Management: Technical Note (http://dx.doi.org/10.22617/TIM189600-2)

*Analyses and insights*

- (2009) Economics of Climate Change in Southeast Asia: A Regional Review (http://hdl.handle.net/11540/179)
- (2011) Accounting for Health Impacts of Climate Change (https://www.adb.org/sites/default/files/publication/28976/heath-impacts-climate-change.pdf)
- (2012) Addressing Climate Change and Migration in Asia and the Pacific (http://hdl.handle.net/11540/918)
- (2013) Investing in Resilience: Ensuring a Disaster Resistent Future (http://hdl.handle.net/11540/89)
- (2013) Economics of Climate Change in East Asia (http://hdl.handle.net/11540/69)
- (2017) Meeting Asia's Infrastructure Needs (http://dx.doi.org/10.22617/FLS168388-2)
- (2017) A Region at Risk: The Human Dimensions of Climate Change in Asia and the Pacific (http://dx.doi.org/10.22617/TCS178839-2)
- (2017) Economics of Climate Change in Central and West Asia (adaptation component) (https://www.adb.org/sites/default/files/project-documents/44068/44068-012-tacr-en_0.pdf)
- Climate and Disaster Risks and Adaptation Investment Opportunities in the Asia-Pacific Region (forthcoming in 2019)

### Practical operations guidance

*General guidance and tools*

- (2013) Aware for Projects (an online project climate and disaster risk screening tool);
- (2014) Climate Risk Management in ADB Projects (https://www.adb.org/sites/default/files/publication/148796/climate-risk-management-adb-projects.pdf)
- (2015) Economic Analysis of Climate Proofing Investment Projects (https://www.adb.org/sites/default/files/publication/173454/economic-analysis-climate-proofing-projects.pdf)
- (2017) Natural Hazard Data: A Practical Guide (http://dx.doi.org/10.22617/TIM178692-2)
- (2017) Disaster Risk Management and Country Partnership Strategies: A Practical Guide (http://dx.doi.org/10.22617/TIM178691-2)
- (2017) Disaster Risk Assessment for Project Preparation: A Practical Guide (http://dx.doi.org/10.22617/TIM178893-2)
- (2018) Spatial Data Analysis Explorer (SPADE) (https://development.asia/explainer/using-spatial-cloud-computing-build-livable-cities)
- Guidance on Climate-Resilient Infrastructure Design by Using the Results of Extreme Rainfall Value Analysis (forthcoming in 2019)

*Sector-specific guidance*

- (2011) Guidelines for climate proofing investment in the transport sector (road infrastructure projects) (https://www.adb.org/sites/default/files/institutional-document/32772/files/guidelines-climate-proofing-roads.pdf)
- (2012) Guidelines for climate proofing investment in agriculture, rural development and food security (https://www.adb.org/sites/default/files/institutional-document/33720/files/guidelines-climate-proofing-investment.pdf)
- (2013) Guidelines for climate proofing investment in the energy sector (https://www.adb.org/sites/default/files/institutional-document/33896/files/guidelines-climate-proofing-investment-energy-sector.pdf)
- (2016) Guidelines for climate proofing investment in the water sector (water supply and sanitation) (https://www.adb.org/sites/default/files/institutional-document/219646/guidelines-climate-proofing-water.pdf)

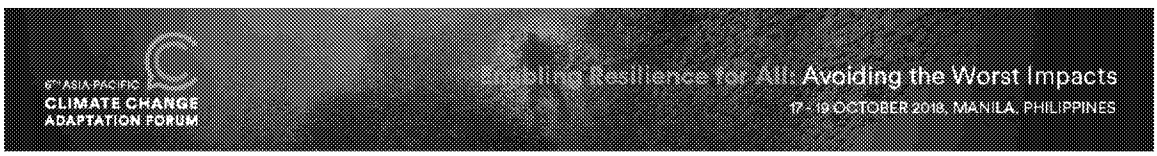
## Box 4: ADB staff training workshop on project climate risk management

As part of the response to the review of ADB's project climate risk management processes and practices, efforts have been made to re-orient the project level climate risk and adaptation assessments so that they focused on evaluating the project objectives that could be most vulnerable to climate change. A training session was organized on 22-23 November 2018 to brief operations teams on this updated approach, using worked examples. The one and a half day's session was structured around a series of five relatively self-contained modules. Proceedings of the training, including presentations and open discussions, are recorded on digital files so they can be accessed by staff on-demand as their schedules permit.

The five modules of the training are:

- **Module 1** – Understanding the project and focusing on what matters
- **Module 2** – Defining decision-led climate information and undertaking risk analysis
- **Module 3** – Identifying adaptation options in the context of uncertainty and timing
- **Module 4** – Conducting economic and financial analysis of risks and adaptation options
- **Module 5** – Developing funding proposals for implementing adaptation interventions

## Box 5: The 6th Asian-Pacific Adaptation Network Forum




The 6th Asia-Pacific Adaptation Network (APAN) Forum was held on 17-19 October 2018 in ADB Headquarters in Manila, the Philippines (http://www.asiapacificadapt.net/adaptationforum2018/). The APAN forum is the largest gathering of adaptation practitioners in the Asia and Pacific region. Co-hosted by the Government of Palau, the Philippine Climate Change Commission, and ADB, together with the APAN secretariat at UN Environment, the 6th APAN Forum has an overall theme of "Enabling Resilience for All: Avoiding the Worst Impacts" and features interactive sessions, panel discussions, and knowledge exchange. Under the broad theme of resilience, the Forum is structured around four streams, focusing on the resilience of (1) human and social systems; (2) ecological systems; (3) industry and the built environment; and (4) island communities, respectively. More than 1,000 scientists, government officials, representatives from civil society and businesses, as well as development partners from 60 countries participated in the 3-day deliberations. Urgent needs for taking action was called for, and a wide range of resilience solutions in action were shared and discussed throughout the forum sessions.

### *3.2 Catalyzing Action and Investment through Partnerships and networks*

Successful action on building resilience to disaster risks and climate change impacts will depend on strong partnerships and networks between development partners, and on working with, and supporting the collaboration of, other subnational and non-state actors such as municipalities, private and state-owned companies, civil society groups, professional associations and the academe, to name a few.

*Knowledge and action networks*

Working with knowledge partners, such as leading academic institutions and multilateral research organizations, has facilitated greater access to technical and scientific expertise in expanding the knowledge on climate and disaster resilience and supporting resilient development decision making. Notable collaborations have included work with:

- The World Health Organization and Food and Agriculture Organization on health impacts of climate change (ADB, 2011b);
- The International Association of Insurance Supervisors for strengthening observance of international principles and standards for the supervision of insurance and reinsurance;
- The University of Adelaide on migration (ADB, 2012);
- The Potsdam Institute for Climate Research on the human dimensions of climate change (ADB, 2017b);
- The UK Met Office and the Commonwealth Scientific and Industrial Research Organization of Australia on building resilience to extreme weather events including through the provision of science-based climate services;
- The World Bank on producing a set of climate and disaster risk country profiles for all ADB's DMCs (ADB, 2019b);
- Various members of the Consortium of International Agricultural Research Centers on the development and field testing of a number of resource conservation technologies and drought-and-flood-resistant crop varieties to support adaptation in the agriculture sector;
- Government of Japan (Ministry of Environment), on an ongoing basis, on a range of climate change adaptation and resilience initiatives including the development of the Asia-Pacific Adaptation Knowledge Platform (AP-PLAT);
- Partners of APAN notably on the organization of the APAN forums.

In addition, ADB actively participates in a range of multilateral partnerships and networks to promote the implementation of climate and disaster resilience policies and practices within various international policy frameworks and agreements, including:

- Joining the joint Multilateral Development Banks (MDBs) declaration on aligning activities with the objectives of the Paris Agreement;12
- Actively contributing to the work of the joint MDB Working Group on Finance Tracking on the development of climate resilience metrics, with a view to providing a more effective measurement of the resilience outcome of investments;
- Working closely with other IFIs to scale up support to developing countries to enable them to deliver on the 2030 development and climate agenda;
- As a member of the NDC) partnership together with other countries and international organizations committed to ambitious implementation of NDCs under the Paris Agreement and the 2030 Sustainable Development Goals
- As a member of the InsuResilience Global Partnership (see Box 6).

12 The declaration was announced at the 24th Session of the Conference of the Parties to the UNFCCC: https://www.ebrd.com/news/2018/mdbs-make-joint-declaration-on-climate-finance-alignment.html

### Box 6: InsuResilience Global Partnership for Climate and Disaster Risk Finance and Insurance Solutions

Launched at the 2017 UN Climate Conference in Bonn, the InsuResilience Global Partnership is a platform for inclusive collaboration, shared learning and delivery on climate and disaster risk finance and insurance solutions, bringing together developing countries, development partners, private sector, international organizations and civil society. The vision of the Partnership is to strengthen the resilience of developing countries and protect the lives and livelihoods of poor and vulnerable people against the impacts of disasters. Its central objective is to enable more timely and reliable disaster response through the use of climate and disaster risk finance and insurance solutions. It builds on the collaboration between countries of the Group of Twenty and the Vulnerable Twenty Group.

Hosted by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), the InsuResilience Global Partnership has over 60 partners representing countries, civil society, international organizations, the private sector, and academia.

Membership enables countries and stakeholders to play a role in shaping a growing community on building financial protection to disasters. The Partnership facilitates access to other key stakeholders to exchange experiences, learn from one another, and drive impact together. Members can engage in working groups, access webinars, participate in the annual Partnership Forum, feature their work in the Partnership newsletter; and influence strategic decision-making through potential invitations to join the High-Level-Consultative Group.

*Partnerships for finance*

Partnerships for finance have played an important role in expanding ADB's support to its DMCs for building resilience to climate and disaster risks. These financial partnerships are diverse in nature: they range from multilateral to bilateral, from technical assistance projects, trust funds to investment programs. Box 7 presents some of the key multilateral funds that support ADB's climate resilience operations. In addition, a range of bilateral partnerships have also been leveraged to provide additional co-financing for climate resilience initiatives, through ADB administered special funds and facilities. These include:

- Integrated Disaster Risk Management Fund; Canadian Climate Fund for the Private Sector in Asia (I&II): Canada
- Urban Climate Change Resilience Trust Fund: Switzerland, United Kingdom, United States and the Rockefeller Foundation; and
- Japan Fund for Poverty Reduction: Japan

## Box 7: Major Multilateral Funds Supporting ADB's Climate Resilience Operations

**Climate Investment Funds (CIFs).** The CIFs have been one of the largest sources of external climate finance that ADB has accessed for its DMCs. Of particular relevance is the **Pilot Program for Climate Resilience** (PPCR), a $1.3 billion programme of grants and concessional loans with the aim of achieving transformational change towards climate resilient development in recipient countries. The PPCR supports developing countries and regions and has been instrumental in building ADB's portfolio of adaptation projects in the region. It assists governments in integrating climate resilience into strategic development planning across sectors and stakeholder groups, and provides finance to put these plans into action, piloting innovative public and private sector solutions. ADB has been working with the PPCR, providing ADB finance (grants and concessionary loans) to recipient countries to help leverage PPCR funding. PPCR countries/regions include Bangladesh, Bhutan, Cambodia, Kyrgyz Republic, Nepal, Pacific Region, Papua New Guinea, Philippines, Samoa, Tajikistan and Tonga.

**Green Climate Fund (GCF).** The GCF is now the largest source of international climate finance. ADB has been supporting DMCs, providing leveraging finance to help access the fund. ADB was among the first organisations to be accredited as a multilateral implementing entity under the GCF, and the ADB project "Fiji Urban Water Supply and Wastewater Management" was one of the first eight projects approved by the GCF Board in November 2015, securing $31 million in grant financing. This project established an important mode of collaboration between the GCF and ADB, through which the GCF provides grant finance to ensure the climate resilience of loan-financed development projects. The GCF co-chairs have encouraged ADB to develop a regional program for the Pacific to address climate action in these vulnerable countries. ADB is also examining other avenues for accessing GCF for its DMCs. ADB has received $265 million from the GCF, with 6 approved projects with adaptation components:

- **Fiji:** Urban Water Supply and Wastewater Management project ($31million grant, approved in November 2015);
- **Nauru:** Climate Resilient Port project ($27m grant, approved in October 2017);
- **Kiribati:** South Tarawa Water Supply project ($29m grant, approved in October 2018);
- **Tajikistan:** Hydromet project ($5m grant, approved in March 2018);
- **Cambodia:** Climate-Friendly Agribusiness Value Chains ($30m grant, $10m loan, approved in March 2018); and
- **Mongolia:** Ulaanbaatar Affordable Housing and Urban Renewal ($50m grant and $95m loan, approved in March 2018).

**Global Environment Facility (GEF).** ADB has been working closely with the GEF since the late-1990s, and since 2002 has served as one of the 10 agencies with direct access to GEF resources. GEF provides incremental co-finance that can be blended with ADB grants, loans and other financial products to support the delivery of global environmental benefits. Since 2001, the GEF Council has approved approximately $120 million in grants to ADB administered climate change projects.

**Nordic Development Fund (NDF).** The NDF is a joint development finance institution of Denmark, Finland, Iceland, Norway, and Sweden. It provides technical assistance for CRM capacity development, climate resilience for urban and rural infrastructure and climate resilience in the health sector.

## C. Moving forward – scaling up investment in climate and disaster resilient infrastructure in Asia and the Pacific

In light of the unprecedented investment needed for the region's infrastructure in the coming decades, and the growing risk of climate change impacts, there is an urgent need to scale up investment in climate and disaster-resilient infrastructure in Asia and the Pacific. Guided by its Climate Change Operational Framework 2017-2030 and Strategy 2030, and building on the efforts made and insights gained to date, ADB is well placed to step up action. To achieve the ambitious target set out in the Strategy, enhanced efforts will be made with in three key areas: 1) knowledge and capacity; 2) climate and disaster resilient design practices; and 3) financing.

### 1. Enhancing knowledge base and building capacity

#### *1.1 Strengthening knowledge base*

While the evidence is growing, significant gaps remain on what works for infrastructure resilience. While ADB will continue to develop the knowledge base on disaster risk and climate model projections, through to the monitoring and evalution of resilience results. A number of priorities are highlighted below.

A first priority is to improve knowledge on how structural and non-structural resilience options perform, particularly the new focus on holistic approaches (integrating eco-based, finance, and social and institutional resilience), implemented individually or in portfolios.

As finance scales up, there will be an increasing need to make sure ADB's resources are used effectively, efficiently and equitably. This necessitates a greater focus on the economics of resilience. This includes the need to strengthen economic appraisal of investments, and to build the evidence base on the costs and benefit of resilience. It also needs to take greater account of how best to build economics into decision making under uncertainty, noting the need for pragmatic approaches that fit within the ADB project cycle, and the available time and resources. Supporting this, there is a priority to learn more on how to program resilience, with more focus on the barriers that exist and how these can be overcome. This will help to maximize leveraging with country and private sector finance to deliver at scale. A related issue is to strengthen the downstream implementation of resilience, contributing to the delivery of iterative adaptive management, as well as increasing monitoring and evaluation.

There is also an increasing recognition of the risk of cascading impacts of disasters on unaffected sectors and geographies (Dawson et al, 2016). Infrastructure services such as heating, lighting, mobility and sanitation are essential for modern society and they are increasingly reliant on each other (e.g. for power, control, and access, and through ICT links). Damage to infrastructure in one sector or geography can therefore lead to important indirect (cascading) economic losses via interdependent infrastructure linkages, such as the consequences of damage to electricity supply or transmission infrastructure on ICT and transport networks. A failure to make infrastructure investments resilient can therefore have important knock-on effects, affecting wider productivity and services. Of particular concern, systemic risks due to extreme weather events can lead to the breakdown of infrastructure networks and critical services such as electricity, water supply, health and emergency services. The main interdependencies and interconnectivities are centered on energy, water, transport and ICT. These cascading risks require a systems approach, i.e. to consider infrastructure resilience as part of a wider system. This requires a more integrated approach in assessing climate and disaster risk, exploring the consequences of damage beyond impacts on the functioning of the individual assets alone.

Ongoing and future technical assistance support could play a key role in addressing these critical knowledge gaps. In addition, systematically documenting and widely sharing experiences from a growing diversity of resilience practices could make a significant contribution to the ongoing knowledge development and learning. Further, new knowledge partnerships could be leveraged to facilitate learning and co-production of knowledge, particularly in areas where critical knowledge and skills gaps remain.

### *1.2 Capacity building*

Designing and delivering infrastructure for a changing and uncertain climate will require new skills and abilities in a diversity of fields. This represents a particular challenge within Asia and the Pacific where there is not yet ready access to significant financial resources or cutting-edge expertise. Formal education as well as technical and vocational education and training in this field creates a foundation and requires the development of appropriate curricula and modules for training professionals. Learning by doing is important, given the need to both move forward and to develop better approaches to the challenges of addressing multiple hazards and the uncertainty associated with climate change. But it is also very important to learn from others, to avoid reinventing the wheel and to accelerate learning.

## 2. Strengthening and promoting the application of climate and disaster-resilient infrastructure design

### *2.1 Extending the CRM up- and down-stream from project development*

ADB has recently taken stock of its experience from 5 years of climate risk management and resilient investments to date, as part of a program of continuous review and improvement. This has identified priorities for improving the CRM framework and the integration of resilience. Among others, areas identified for improvement include: (1) provision of climate services including climate data and information relevant for resilience investment decision making; (2) economics analysis of resilience interventions in investment projects; (3) professional development and training for key project partners. In response, ADB has started updating the guidance on CRAs to enhance the climate proofing of new investments, improve the guidance on climate risk screening and resilient project design, and provide more targeted supporting material and case studies. These activities will help improve the resilience of the existing and new project portfolio to ensure that infrastructure investments are climate smart.

ADB also recognizes that over the next decade, climate change could have increasingly large impacts that will start to threaten economic growth and development in Asia. This will also require a move from the current focus on making sure existing investments are resilient (climate proofing) towards investments that target climate change impacts, as already happens in the context of disaster risk management.
This can be seen as a change in the ADB climate portfolio from building the "resilience of investments" to financing "resilience through investments" for client countries.

Underpinning both current and future investments, it is important to move the CRM upstream, identifying early entry points that help introduce climate and disaster-resilient infrastructure development in country partnership strategies and country operations business plans. This recognizes there is a strong economic rationale for resilience at the strategic level, and that greater impact can be achieved if resilience is integrated earlier in the investment project cycle. To help deliver this, a series of supporting upstream actions are underway to scale-up the development and redevelopment of resilient infrastructure.

### *2.2 Developing and promoting climate-resilient infrastructure design*

To ensure infrastructure resilience in a systematic manner, it is important that building codes and engineering design standards are updated to account for a changing climate. The development and revision of standards is typically a slow process. While much climate science has been advanced to appropriate levels to inform decisions, a central challenge is to bring the advancement to the engineering practice. Building on analyses and insights gained from adjusting engineering design parameters at project level, there is scope for multilateral institutions such as ADB to play a key role in further developing and promoting the application of climate and disaster risk-informed engineering design practices. For example, much potential exists for mainstreaming resilience into infrastructure development through the co-development and adoption of updated design standards during the development of sectoral master plans.

Looking beyond the MDBs, it is likely that there is a role for standards and norms. These will be important for incentivising private sector resilience, as well as the uptake of resilience in commercial bank lending. ADB is contributing to this debate through collaboration with international standard setting bodies and the emerging development of industry standards and guidance on climate resilience.

## 3. Increasing finance

### *3.1 Public sector important in setting standards and creating incentives*

In spite of the upward trend in reported investment in climate change adaptation and resilience, there remains a notable gap between what is required to deliver resilient infrastructure and what is currently available in the region. Moving forward, to deliver climate and disaster resilient infrastructure at scale, significant finance, both public and private, needs to be mobilized. Governments could use their purchasing power to increase the resilience of their investments. For example, national or subnational authorities could promote "code plus" in government-funded infrastructure investments, where standards exceed the minimum life safety requirements of local building codes. There is also a need, particularly in the short term, to incentivize investments (e.g., resilience tax credits, loans, grants, etc.) to accelerate investments in resilience.

### *3.2 Private sector engagement key to mobilizing resilience finance at scale*

However, a lynchpin in infrastructure resilience financing efforts will be the engagement of the private sector, which is responsible for constructing and managing a significant share of the region's infrastructure. This will involve using ADB funding to leverage private sector finance to expand resources beyond the existing funds and modalities.

*Climate-related financial disclosure by businesses important for catalyzing proviate sector CRM and investment*

An obvious first priority is to raise awareness on climate risks, so that these issues become integrated in financial markets, commercial lending, due diligence, and company risk analysis. The incentives for financial markets to price in climate change risks have increased recently with initiatives such as the Task Force on Climate-related Financial Disclosure (TCFD)[13]. The initial focus has been on the risk of stranded assets because of mitigation policy and carbon taxation, i.e. the risk thatinvestment in, for instance, fossil fuel reserves or generation plants are unable to earn an economic return some time prior to the end of their originally assumed economic life (McGlade and Ekins, 2015; Mecure et al, 2018)[14]. However, there is an increasing recognition of the need to assess and disclose physical climate impact risks in investment proposals. The disclosure of this information will promote the integration of climate risks into private sector decisions[15].

There is also an opportunity to use public finance to address the barriers to private sector investment, creating the enabling conditions for the private sector through awareness raising and information, technical assistance support and demonstration studies to address risk perceptions. In this regard, ADB will continue to support and collaborate with initiatives that promote awareness and create the enabling environments needed to unlock private financing for investment in climate and disaster-resilient infrastructure, including through contributing to initiatives under the TCFD.

*Unlocking private sector finance through insurance*

Moving beyond this, there are major opportunities through insurance, and this could be a crucial driver to unlock major private sector funding to enhance resilience where ADB has a role, as is already planned through ACliFF. The insurance industry already provides coverage for engineering and asset risk through to third party liability risk coverage for infrastructure. There are major opportunities for new technologies as well as innovation and implementation of market-based solutions. The industry has developed risk coverage solutions across the infrastructure lifecycle, and has extended this to innovative risk transfer solutions. In 2017, the re/insurance industry paid out $144 billion for disaster insured economic damages, the highest amount ever. It has helped to develop the catastrophe bond market with

13 Established by the G20's Financial Stability Board (https://www.fsb-tcfd.org).

14 Recent analysis of the risks of stranded assets has been undertaken in Asia (Caldecot et al, 2018).

15 Although it will have some unintended consequences, notably by drawing attention to the higher climate risks in the most vulnerable countries, and potentially reducing investment or increasing the cost of borrowing – something that is already starting to happen, as seen with the addition of basis points for developing countries (ICBS and SOAS, 2018).

currently more than $30 billion outstanding bonds issued: the first public sector cat bonds triggered payouts in 2016 and 2017. Yet these instruments remain significantly under-utilized in ADB's DMCs to date.

There are also more advanced and innovative approaches that could be developed, with a range of other insurance instruments (Lloyds, 2018), such as insurance-linked loan packages (infrastructure loans which include built-in insurance) resilience impact bonds (pay-for-performance contracts) and resilience bonds (risk-linked financing mechanism similar to catastrophe bonds, but which take account of resilience measures).

*Leveraging public-private partnerships*

The private sector can also play a role in helping to meet infrastructure resilience needs. Public-private partnerships (PPPs) are becoming part of the broader solution to develop and finance infrastructure, as well as to maintain and operate projects to enhance their economic and physical performance. There is therefore an important role for PPPs in enhancing the disaster and climate resilience of infrastructure investments. So far, the public sector has typically borne the disaster risks, and this is partly contributed to the development of PPPs. However, going forward, a major challenge for the design and preparation of private sector bids for climate resilient infrastructure is the extent to which climate risk is transferred to the private sector. This issue will be particularly acute for PPPs, due to their highly prescriptive performance payment regimes. For example, private operators would have difficulty continuing in a PPP project because of reduced profitability if the contracting authority asks them to add an earthquake rider to their fire insurance. Hence, despite recognizing the need to obtain insurance, decisions are made by considering the regional characteristics and availability of insurance.

One area of focus is to provide the knowledge and information to help the private sector enhance resilience. ADB has provided strong advisory and financial support to help address project development for conventional projects, including approaches for PPPs. In this context, ADB with others have developed and funded comprehensive online project preparation platforms, such as SOURCE, which supports "best-in-class" preparation of PPP infrastructure projects. SOURCE addresses the difficulties encountered by a lack of standardization in project prioritization, planning, preparation and execution, and help to strengthen the project pipeline of sustainable public private partnership infrastructure projects. It was originally developed by ADB, and was launched globally in 2016. At present, resilience is not included in the project stock-taking, but adding questions related to resilience would be one way of increasing awareness and uptake.

The consideration of resilience in PPPs is also at an early stage, with climate risks currently not considered explicitly or allocated to a specific party in a standard PPP risk allocation framework. However, introducing a robust, well-defined and fair PPP scheme with an appropriate allocation of risk, that addresses the expectations of the investment community, could help resilient infrastructure projects demonstrate that they can generate attractive and secure returns.

Policy and institutional reforms in PPP frameworks are required as well. This might include the need to translate the public climate risk screening and resilience building processes (and lessons) into private and PPP projects; enhanced land use planning policies and their enforcement to avoid investment in high risk locations; and the use of higher design standards. There might also be some role for insurance protection in national infrastructure policy.

*Exploring other innovative financing instruments*

Finally, with the increase in natural hazards projected under climate change, there are some other innovative financing instruments that could help. These could include green and climate bonds. While these have primarily been focused on mitigation or re-financing, there is the potential for climate adaptation bonds. In August 2016, in line with its Green Bond Program, ADB raised $1.3 billion to help finance climate change mitigation and adaptation projects with the issue of dual-tranche 3-year and 10-year green bonds, following its inaugural green bond issue in March 2015. Further, in March 2016, ADB supported the region's first certified climate bond for a geothermal power project in the Philippines. This was the first certified climate bond in Asia and the Pacific, and the first ever climate bond for a single project in

an emerging market. In addition, concerted efforts are being made, by ratings agencies (e.g. S&P Global Ratings, 2017) and initiatives such as the CBI and the World Bank Group,[16,17] to develop standards for climate resilience investments with a view to increasing the issuance of green/climate bonds to finance climate resilience projects. ADB has been actively engaged in these efforts, and seeking to explore opportunities arising from these emerging developments for innovative resilience finance.

16 An expert group has been established under the CBI to develop a set of standards for certifying adaptation and resilience projects, to be launched later in 2019.

17 The World Bank Group, in consultation with a wide range of partners including ADB, is developing a Rating System for Project Resilience.

## D. Conclusions

There is an urgent impetus for prioritizing, planning, designing, executing and scaling up investments in climate and disaster resilient infrastructure in Asia and the Pacific. This paper sets out recent experience and insights from the Asian Development Bank in this area, and how these lessons are being considered to develop a new vision for climate and disaster-resilient infrastructure investment in the Region.

ADB has identified 'tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability' as one of seven operational priorities in its new 'Strategy 2030'. This calls for a major scaling-up of investment in climate and disaster-resilient infrastructure, and to support this, ADB has pledged to provide $80 billion of cumulative climate finance from its own resources by 2030. This recognizes that action on climate change and disaster resilience will support the delivery of other Strategy operational priorities, as well as Sustainable Development Goals.

However, the volume of regional infrastructure investment needed, as well as the level of disaster and climate change risks in Asia and the Pacific, mean that scaling-up ADB's current approach alone will be unlikely to deliver the Strategy's ambitions. Instead, new types of investments, innovative financial instruments, and greater leveraging of private sector finance are needed.

This paper first looks at ADB experience to date and draws lessons on what works, identifying good practice that can be scaled up. This includes insights on the programming and financing of disaster risk reduction, with the need to broaden investment to include different types of infrastructure (gray and green infrastructure). It also includes changes to the climate risk management framework, to enhance resilience in future infrastructure investments with greater adaptive management, improve economic appraisal, and focus on addressing information, policy and institutional barriers. Alongside this, the report identifies the role for new financial instruments, building on current pilots and applying at scale with contingent credit, insurance and risk transfer mechanisms. The paper then considers the additional actions that could help deliver resilient infrastructure in the region including what ADB could do differently. A number of priorities have been identified.

First, there is already a move in ADB to develop a holistic resilience approach. This will build resilience to a wide range of shocks and stresses, extending beyond physical infrastructure to include financial resilience, eco-based resilience, and social and institutional resilience. This will deliver major economic benefits, and it will build resilience at all levels, for individuals, households, communities, businesses, and nations. This has the potential to deliver much greater resilience impact.

Second, there are opportunities to explore, pilot and scale-up new and innovative financial approaches and instruments for resilience. These build on ADB's recent success in contingent finance, and national disaster risk management funds, but could extend to other national level initiatives, as well as risk transfer at multiple scales (from national to local) using insurance.

Third, there is a set of forward-looking activities which are centered on leveraging private sector finance, to unlock investment in climate and disaster-resilient infrastructure. This could include advisory and financial support to build resilience in project development, along with the strengthening of the climate risk management and resilience building processes. It could also include disaster and climate risk sharing and risk transfer in public-private partnerships, as well as enhanced insurance and reinsurance. Finally, it could include dialogue and development of capital market solutions.

Complementing all of the above areas, ADB will continue to support and collaborate with initiatives that promote awareness and create the enabling environment for communities, countries, development partners, financial institutional, and the private sector to build climate and disaster-resilient infrastructure in the Region and beyond.

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